Friday, March 31, 2017 8:39 AM

Circuit Diagrams and Kirchhoff's Laws

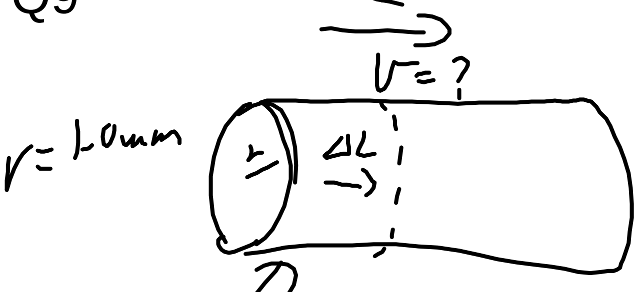
Homework:
p478 Q31

I=7.60A
240V
rate of water=? = m/t
change in temperature = 6ºC

$Q = mc\Delta T$
$P = VI = Q/t$
$VI = (m/t)c\Delta T$
$m/t = VI/c\Delta T$
$m/t = 240 \times 7.6/(4180 \times 6) = 0.0727$ kg/s

Q9

$I = 1.0A = \frac{Q}{t} = \frac{\rho V}{t}$



$\rho = \frac{Q}{V} = 10^{29} \frac{e^-}{m^3}$

$V = \pi r^2 \Delta L$

$I = \frac{\rho V}{t} = \pi r^2 \rho \frac{\Delta L}{t}$

$$I = \pi r^2 \rho v$$

$$v = \frac{I}{\pi r^2 \rho} = \frac{1.0\,A \left(\frac{e^-}{1.6\times10^{-19}\,C}\right)}{\pi (1.0\,mm)^2\; 10^{29}\,\frac{e^-}{m^3}}$$

($1.0\,mm = 10^{-3}\,m$)

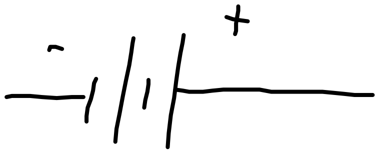
$$\boxed{v = 2.0\times10^{-5}\ m/s}$$

Circuit diagrams:

electrochemical cell:

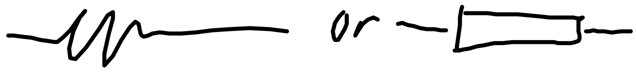
negative — long line = positive

Battery



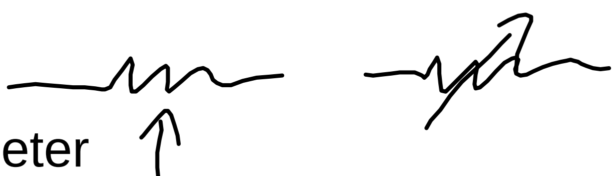
wire

resistors

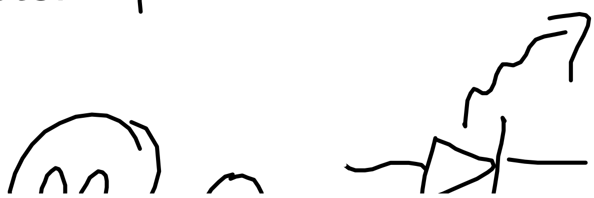


book

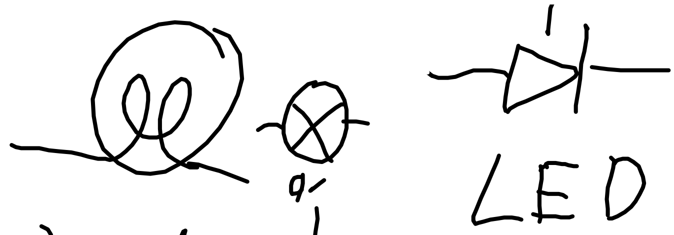
Variable resistor
or rheostat or potentiometer



light… [illegible]



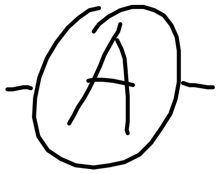
lights



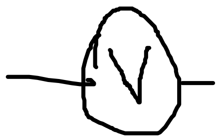
incandescent

incandescent

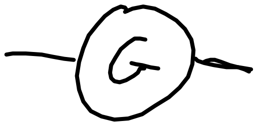
ammeter - measures current
<u>ALWAYS PUT AMMETERS IN SERIES</u>



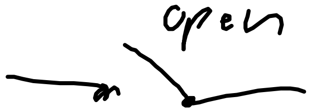
Voltmeter - measures potential difference between two points in the circuit.
Put the voltmeter in parallel across the element you are measuring.



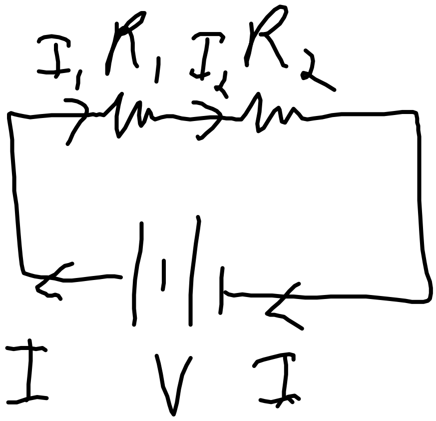
Galvanometer - measures very small currents.



Switch



Let's look at series and parallel circuits



$$\frac{V}{I} = R_T$$

equivalent resistant

$$R_T = R_1 + R_2$$ in series

what is the current through R_1 and R_2?

Same as $I = I_1 = I_2$ series

How about voltage?

$V_1 = IR_1 \quad V_2 = IR_2$

by conservation of energy

$P_{Battery} = VI = P_{R_1} + P_{R_2}$

$VI = V_1 I + V_2 I$

Kirchhoff's → $\boxed{V = V_1 + V_2}$
Loop law
- voltages around a loop add to zero

Parallel Circuits

By law of conservation of charge

$Q_{in} = Q_{out}$

$I_{in} = I_{out}$

+ V

$$I_{in} = I_{out}$$

Kirchhoff's Junction Law

$$I = I_1 + I_2$$ Parallel

$$P = P_1 + P_2$$

$$VI = V_1 I_1 + I_2 V_2$$

therefore $$V = V_1 = V_2$$ Parallel

$$I = I_1 + I_2$$

$$\frac{V}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$ Parallel

e.g. You connect a 6.00V Battery to a 350Ω

resistor and a 100 Ω (35fs)
resistor.

Determine the voltage across, current through and power output of each resistor when they are
a) in series with each other
b) in parallel with each other
Draw a circuit diagram showing an ammeter and voltmeter connected to the 100 ohm resistor.

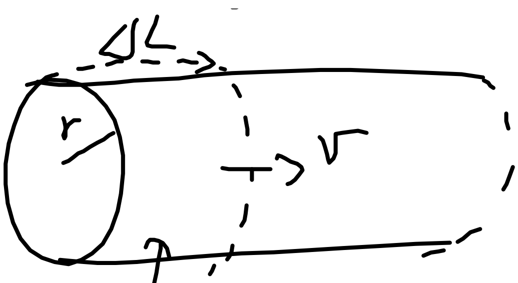
p499-500 Q1-11 odds
q 5 and 11 - redraw the diagram to show series and parallel parts

Lab next Thursday p85-89 Kirchhoff's laws and series and parallel circuits

Q31
$I = 7.6A$, $V = 240V$
$\Delta T = 6^oC$ $c = 4180$ J/kg^{o}C
rate = m/t
$P=VI = Q/t$
$Q= mc\Delta T$
$VI=(mc\Delta T)/t$
$VI/c\Delta T = m/t = 240x7.6/(4180x6)=0.0727$ kg/s

Q9

$I = 1.0A = \frac{Q}{t}$



$$\rho = \frac{10^{29} e^-}{m^3} = \frac{Q}{V} \rightarrow Q = \rho V$$

$$V_{cylinder} = \pi r^2 \Delta L$$

$$I = \frac{Q}{t} = \frac{\rho V}{t} = \pi r^2 \rho \frac{\Delta L}{t}$$

$$\frac{\Delta L}{t} \rightarrow v$$

$$I = \pi r^2 \rho v$$

$$v = \frac{I}{\pi r^2 \rho} = \frac{1.0\,A}{\pi (1\,mm)^2 \frac{10^{29} e}{m^3} \left(1.6\times 10^{-19} \frac{C}{e}\right)}$$

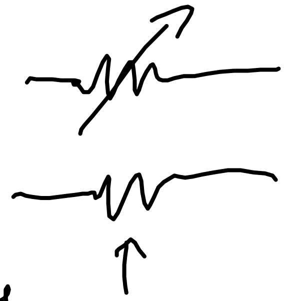
$$A \rightarrow \frac{C}{s}, \quad mm \rightarrow 10^{-3}$$

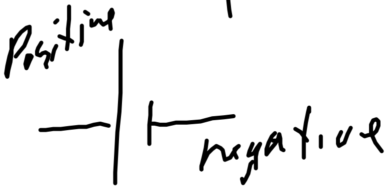
$$\boxed{2.0\times 10^{-5}\ m/s}$$

Circuits
Symbols:

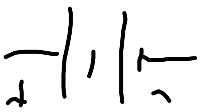
light bulb

resistor: 

variable resistor
(rheostat or potentiometer) 

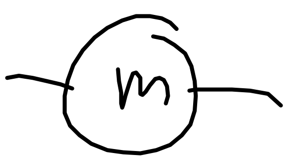
Electrochemical cell 

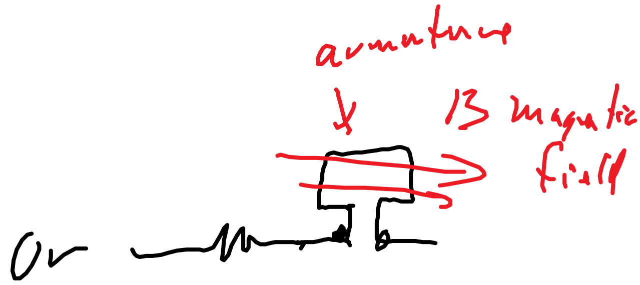
current usually flows out of the positive end and into the negative end, equally (conservation of charge, charge out=charge in or current out=current in).

battery 

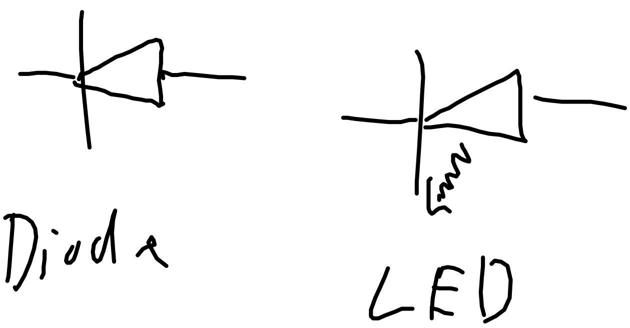
armature

wire 

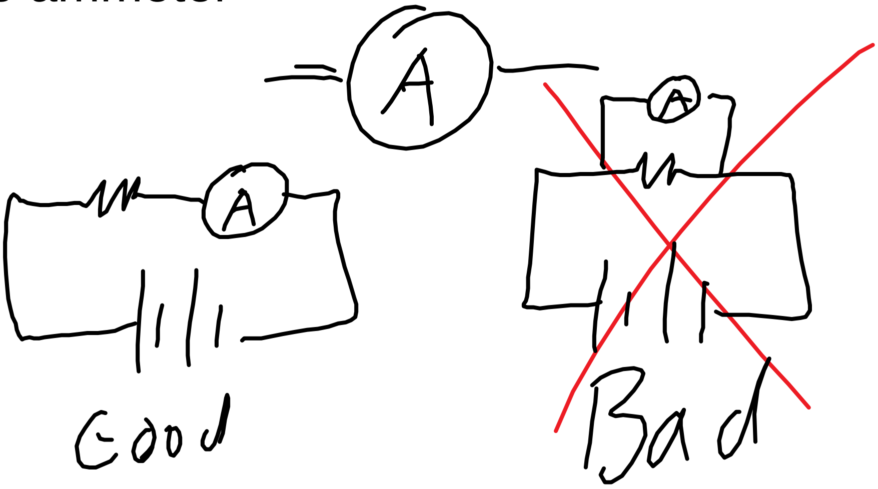
motor 



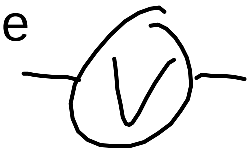
switch 

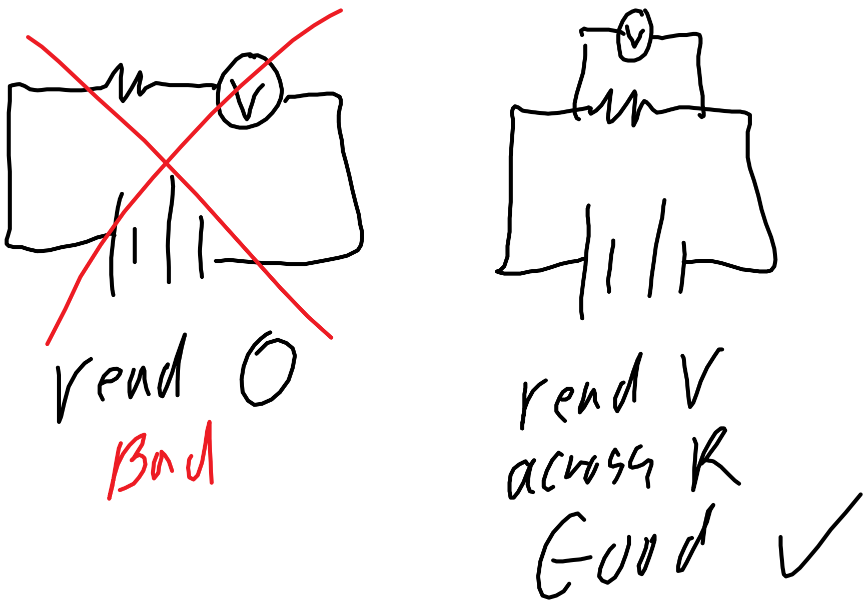


Ammeters - measures current
MUST BE CONNECTED IN SERIES- or you can fry the ammeter

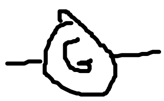


Voltmeter - measure potential difference between two points on the circuit.
In parallel with the element measured.



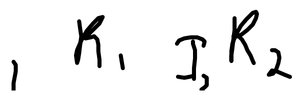


Galvanometer - measures small currents

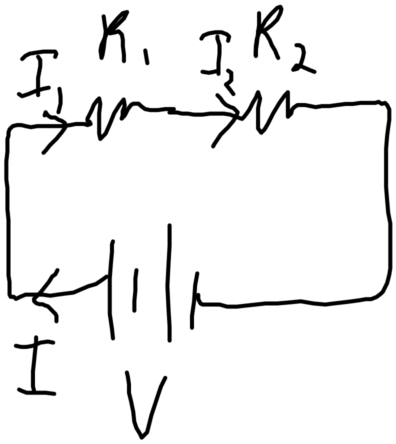


Look at series and parallel circuits and voltage, current, resistance and power.

Series



Series



$$I = I_1 = I_2$$

no charge is lost

By coservation of energy

$$P_{in} = P_{out}$$

$$VI = V_1 I + V_2 I$$

energy given off by resistor 1

resistor 2

$$\boxed{V = V_1 + V_2}$$

Series

Kirchhoff's loop law – Voltages around a loop add to zero ($V_{in} = V_{out}$)

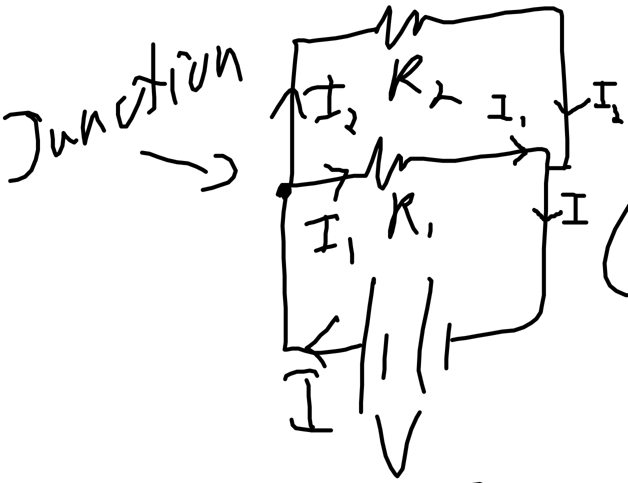
$$R = \frac{V}{I} = \frac{V_1 + V_2}{I} = \frac{R_1 I + R_2 I}{I}$$

V_T I — I - I

↑ equivalent resistance

$$R_T = R_1 + R_2$$ Series

Parallel Circuits



Parallel

$$I = I_1 + I_2$$

→ Junction Law

$$P_{in} = P_{out}$$

$$VI = I_1 V_1 + I_2 V_2$$

$$I = I_1 + I_2$$

$$V = V_1 = V_2$$ Parallel

Circuit elements in parallel

have the same potential diff.

$$I = I_1 + I_2$$

$$\frac{V}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

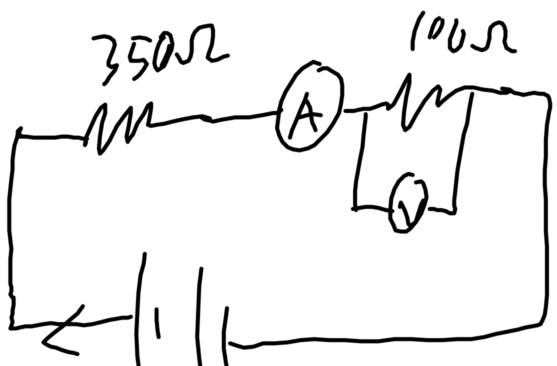
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$ Parallel

Determine the voltage across, current through and power output of each resistor when they are

a) in series with each other

b) in parallel with each other

Draw a circuit diagram showing an ammeter and voltmeter connected to the 100 ohm resistor.



I 6V

$$I = \frac{V}{R_T} = \frac{6.0V}{350\Omega + 100\Omega}$$

$= 13.3\,mA$

$V_{350} = IR = 350\Omega \times 13.3\,mA$

$= \boxed{4.67V}$

$V_{100\Omega} = 100\Omega \times 13.3\,mA = \boxed{133V}$

10^{-3}

$P_{350\Omega} = I^2 R = (13.3\times10^{-3})^2 (350$

$= \boxed{62.2\,mW}$

$P_{100\Omega} = \boxed{17.8\,mW}$